Renewable and Sustainable Energy Reviews 15 (2011) 4223–4235

Contents lists available at SciVerse ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

Attitude and acceptance of offshore wind farms—The influence of travel time and wind farm attributes

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ARTICLE INFO

Article history:
Received 12 April 2011
Accepted 5 July 2011
Available online 23 September 2011

Keywords:
Review
Attitude
Prior experience
Offshore wind farms
Travel time
Wind farm attributes

ABSTRACT

Generally people are more positive towards offshore wind farms compared to on-land wind farms. However, the attitudes are commonly assumed to be independent of experience with wind farms. Important relations between attitude and experience might therefore be disregarded. The present paper gives a novel contribution to this field. First of all, we give a thorough review of the studies that have analysed the relation between experience with wind turbines and attitude. In addition, we supplement the review by analysing the effect of travel distance to the nearest offshore wind farm and the wind farms attributes on attitude towards offshore wind farms. The results point towards that the travel time and the attributes of the nearest offshore wind farm influence the attitude significantly. Travel time has mixed effects on the attitude, whilst offshore wind farms with many turbines generate more positive attitudes compared to wind farms with fewer turbines.

Contents

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doi:10.1016/j.rser.2011.07.130

Table 1
Offshore wind farms in the EU 2008 (based on Table 1 in [1]).

Country	No. of wind farms	Year of installation of the first wind farm	Turbines per farm	Capacity per turbine (app.)[a]	Distance from the shore (km)
Belgium	1	2008	6	5 MW	27–30
Denmark	7	1991	4–80	450 kW–2.3 MW	0.8–17
Finland	1	2008	24	3 MW	<1
Germany	3	2004	1	2.5–5 MW	0.4–1
Ireland	1	2004	7	3.6	10
Italy	1	2008	1	80 kW	20
The Netherlands	4	1994	4–60	500 kW–3 MW	0.03–23
Sweden	4	1998	5–48	560 kW-2.3 MW	3–10
United Kingdom	9	2000	2–30	500 kW–3.3 MW	1–25

[a] The capacity per turbine is estimated by dividing the total capacity of each offshore wind farm with the number of turbines in the wind farm.

1. Introduction

On a global scale, wind power has experienced enormous growth rates and is presently the fastest growing energy source [1]. In this line, one of the areas that is in constant development is how wind turbines are perceived as one of the top solutions to achieve higher levels of renewable energy in the grid [2–4]. Despite the large growth rates, economic infrastructure and policy issues still act as barriers for further wind power development at both national and regional levels [5,6]. In addition, the high density of on-land wind turbines increases the demand for renewable energy with fewer disamenities. On-land turbines are perceived by many people to cause more severe impacts compared to offshore wind farms, which is why the latter is typically preferred [7,8]. The preferences for offshore development might be particularly evident, as the on-land development will amplify the number of people that will have a view to on-land wind turbines from their permanent or summer residence [9], or if the acceptance of on-land wind turbines is dependent on the number of turbines in the area [10,11]. If offshore development costs are driven even further down as proposed by Megavind [12] and discussed in [13], offshore development might increase drastically in the coming decade and remedy some of the problems associated with on-land turbines.

The offshore wind farm capacity in EU has increased, though many countries still only have a few wind farms installed. In Table 1, we show the number of turbines in each country and the date of when the first offshore wind farm was installed. In 2008, 31 offshore wind farms were operating in 9 different countries. Of these, Belgium, Ireland and Italy had their first offshore wind farm installed in 2008, see Table 1 above.

As the table also suggest, only Denmark and UK had more than 5 offshore wind farms installed in 2008. The probability that people have ever seen an offshore wind turbine is thus low in many of the European countries. Potentially, the few offshore wind farms could be one of the explanations for why offshore is preferred to on-land turbines. Unfortunately and as a natural consequence, relatively few studies have focused on the attitude towards offshore wind farms, though the numbers have increased recently, see [8,14,15] just to mention some of the latest papers. Few of these papers have analysed how the otherwise positive attitude might be influenced by experience with offshore wind farms. To the authors' knowledge, except from four Danish studies [9,14,16,17], no other studies have addressed the relation between experience people have with offshore wind power and their attitude systematically. Referring to Table 1, this might be imperative. The distances from the coast the offshore wind farms are located at and the capacity of the used wind turbines vary both between countries and between wind farms in the specific countries. Accordingly, conditional on having experience with an offshore wind farm, this experience can cover all from having seen large offshore wind farms located relatively close to shore (Nysted in Denmark), far from shore (Prinses Amelia in the Netherlands) to individual turbines or small wind farms close to the shore (Lely, the Netherlands).

The latter point is important if attitudes and perceptions are sensitive to the experience people have with wind turbines specifically and wind power in general. If this indeed is the case, the identification of the relations between experience and attitude change would be imperative at several levels. First of all, it will give policymakers, wind power planners and developers a better understanding of how attitudes are formed in a dynamic aspect and what type of experiences it might be advisable to avoid through thorough planning. In the same line, by applying the information in a planning context it would also give important information on the direction in which attitudes might develop conditional on specific wind power development plans. For example in [11] the attitude towards more on-land turbines is analysed and it is tested whether the number of turbines in the local area have an influence on the attitude. The results show that respondents who can see wind turbines from their residence and who have many turbines in the neighbourhood are much more negative towards more turbines. Another example is Ladenburg [14] who finds that the perception of the visual impacts of offshore wind farms varies systematically with prior experience, i.e. the distance of existing wind farms seems to affect the perception towards offshore wind farms. More specifically, the results suggest that people living close to Nysted offshore wind farm, which is located at 6–10 km from the coast, are significantly more negatively inclined towards offshore wind farms than respondents living close to Horns Rev offshore wind farm, located at 14–17 km from the coast. Consequently, locating offshore wind farms too close to the coast might induce more negative perceptions towards offshore wind farms compared to if the wind farms are located at larger distances. Finally, a systematic effect of a prior experience would also suggest that previous studies based on samples with no prior information might be obsolete if the sampled population is expected to gain experience with offshore wind farms in the future.

The present paper aims at bringing a novel contribution to the sparse literature focusing on attitudes towards offshore wind farms at multiple levels. First of all, we use the travel distances from the residence to the nearest offshore wind farm to control potential experience with offshore wind farms. Similar approaches have been used regarding the attitude and distance relation of existing on-land turbines [18–22], but never in relation to offshore wind farms. Secondly, conditional on the nearest offshore wind farm, we analyse if different wind farm characteristics of the individual offshore wind farms in terms of visibility from the coast and the number of turbines influence the attitude. We also use a much larger sample compared to [14]. Finally, we include information regarding the

travel time to all offshore wind farms in Denmark, as opposed to two wind farms in Ladenburg [14].[1]

Based on this analytical framework the results of the analysis suggest that the travel time to the nearest offshore wind farm significantly influences the attitude towards offshore wind farms. Respondents living within 30 min of travel time from the nearest existing offshore wind farm have significantly more negative perceptions. In addition, the further the respondents live from the nearest offshore wind farm, the more negative they are towards offshore wind farms, though at a declining rate. The results also point towards that some of the characteristics of the wind farms influence the attitude. More specifically, larger offshore wind farms seem to increase acceptability, compared to smaller offshore wind farms.

The article is structured as follows. First the paper is put into a broader context by carrying out a literature review focusing on how previous studies have found that different types of experience with wind turbines influence the attitude towards wind power. This is followed by a presentation of the analytical framework, the setup for using travel time as a determinant of attitude, the study, results, discussion and a conclusion.

2. Literature review

The relation between attitude formation and prior experience with wind turbines has to date mainly been analysed in a framework that accounts for effects of primarily on-land turbines in a single dimension. Broadly, the studies have estimated the effect of, for example, distance from the residence of the respondents to a wind turbine and view of turbines on the attitude/perception towards specific or general wind projects. The list of studies is presented in Table 2.

To increase the accessibility of the review and the subsequent results, the studies obtained from the literature are categorised according to the type of location, i.e. offshore, land-based systems or more general attitudes. Within each category, the studies are presented in chronological order by the year of publication. Besides the name of the study, the table lists which prior experience variables were included, whether the variables were significant and in that case the direction of the effect (positive or negative). In this relation, "<0" should be read as the prior experience variable having a negative effect and ">0" as having a positive effect on the stated attitude. If the effect of the variables is marked as ^{NS}, this denotes that the effect is not significant at a 90% level of confidence. A * denotes significance at least a 90% level of confidence.

2.1. Attitudes towards offshore wind farms

The first group of studies analyses how prior experience with wind turbines can influence the acceptance of offshore turbines. Bishop and Miller [23] test for prior information in a study analysing the visual impact from an 18 turbine offshore wind farm located at 4, 8 and 12 km from the coast. In the paper it is tested if respondents living in an area with wind farms perceived the visual impacts from offshore wind farms as more severe when compared to respondents without any contact with wind farms or living in an area with proposed or approved wind farms. The results suggested some influence of prior information, though the prior information effect was ambiguous. More specifically, the negative effect from experience with turbines was found only to be significantly different in the case of visual assessment of the wind farm located at 4 km, but not at 8 and 12 km.

Ladenburg [16] analyses the attitude towards future offshore wind farms in Denmark. In the paper, prior experience is tested using the information on the respondent's view of on-land and offshore wind farms from the residence or summer house. The results suggest that prior experience does not influence the attitude towards future offshore wind farms ($\beta_{View\ On\text{-}Land}{}^{NS}$, $\beta_{View\ Offshore}{}^{NS}$). Accordingly, respondents who can see either an on-land or an offshore wind farm from the residence appear to be equally positive/negative towards offshore wind farms as those who do not have a wind turbine in their viewshed.

A nearly identical approach is used in Ladenburg [14], who analyses the attitude towards the impact on the coastal landscape from offshore wind farms. Besides modelling prior information as a function of view to on-land and offshore wind farms from the permanent or summer residence, the analysis also systematically controls for prior information by sampling respondents with distinctively different levels of experience with visual impacts from offshore wind farms. That is carried out by sampling respondents living close to Nysted I and Horn Rev I offshore wind farms.[2] The simple experience tests (view of on-land or offshore wind turbines) do not indicate an effect of the prior information ($\beta_{View\ On\text{-}Land}{}^{NS}$ and $\beta_{View\ Offshore}{}^{NS}$). However, when making the comparison of perception between the two samples, strong experience effects seem to be present. More specifically, the results point towards that experience with relatively large visual impacts from the Nysted I offshore wind farm has a negative influence on the perception of visual intrusion from offshore wind farms on the landscape.

In a stated behaviour study, Lilley et al. [24] examine the determinants of the propensity to visit a beach in Delaware, US if an offshore wind farm was located at 10 km from the coast. In the analysis they include information on whether the respondents in the survey had ever seen a wind turbine. Having physical experience with wind turbines did, however, not influence the stated visiting propensity significantly. They do not find a significant effect.

In Ladenburg [9] the analysis of prior information is compared to [14,16] extended in another dimension. This is done by including variables controlling for the perceived number of turbines seen on a daily basis. In the analysis of attitude towards existing offshore wind farms, view to on-land turbines has a significantly positive influence on attitude ($\beta_{View\ On\text{-}Land}{}^{*}$). The number of turbines and view to offshore wind farms were on average not found to have any significant impacts on attitude.

2.2. Attitudes towards on-land turbines

Thayer and Freeman [25] test if familiarity influences the attitude towards wind turbines. In their setup, familiarity is defined as seeing a wind turbine at least once a week, whilst respondents who only saw them once every couple of weeks were categorised as unfamiliar. In general, familiar respondents tend to state more negative attitudes, such as seeing wind turbines as "tax shelter", "in-efficient use of the land" and "less attractive". The unfamiliar on the other hand perceived wind turbines to be more "efficient", "organised", "new and interesting" and generally liked them better.

In another study, Lee et al. [26] test the acceptance of different number of wind turbines to be located near the respondents' home between respondents in two samples. In the first sample (Phase I) the respondents had no experience with living near a wind turbine, when the survey was launched. In the second sample of respondents (Phase II) at least one turbine was operating in the locality.

[1] Besides the six "real" offshore wind farms, turbines at Harboøre (not included in Table 1) and Frederikshavn were located just on the coastline at the time the survey was carried out. However, in the present analysis these are not treated as offshore wind farms.

[2] Today, an additional offshore wind farm is located at each of the "older" wind farms, Nysted II and Horns Rev II, respectively.

Table 2
Review of previous studies testing for prior experience effects.[a]

Study	Attitude/perception	Prior experience variable	Effect of prior experience
Attitude/perception towards offshore wind farms			
Bishop and Miller [23]	Perception of visual impacts from offshore wind farms at 4, 8 and 12 km from the shore	Location of on-land turbines in the neighbourhood	$\beta_{\text{Turbines neighbourhood_4 km}}{}^{*} < 0$
			$\beta_{\text{Turbines neighbourhood_8 km}}{}^{\text{NS}}$
			$\beta_{\text{Turbines neighbourhood_12 km}}{}^{\text{NS}}$
Ladenburg [16]	Attitude towards more offshore turbines	View to offshore turbines from permanent residence or summerhouse	$\beta_{\text{View on-land}}{}^{\text{NS}}$
			$\beta_{\text{View offshore}}{}^{\text{NS}}$
Ladenburg [14]	Perception of visual impacts from offshore wind farms	View to on-land turbines from permanent residence or summerhouse	$\beta_{\text{View on-land}}{}^{\text{NS}}$
		View to offshore turbines from permanent residence or summerhouse	$\beta_{\text{View offshore}}{}^{\text{NS}}$
		Systematic differences in prior experience between two samples of respondents	$\beta_{\text{Systematic differences}}{}^{*,\text{b}}$
Lilley et al. [24]	Perception of change in visiting patterns to beaches with offshore wind farms at 10 km from the coast	Has seen a wind turbine before	$\beta_{\text{Has seen a wind turbine before}}{}^{\text{NS}}$
Ladenburg [9]	Attitude towards existing offshore turbines	View to on-land turbines from permanent residence or summerhouse	$\beta_{\text{View on-land}} > 0^{*}$
		View to offshore turbines from permanent residence or summerhouse	$\beta_{\text{View offshore}}{}^{\text{NS}}$
		Number of on-land turbines in the neighbourhood	$\beta_{\text{No. turbines neighbourhood}}{}^{\text{NS}}$
Attitude/perception towards on-land wind farms			
Thayer and Freeman [25]	Multiple attitude questions	Frequency of turbine encounters	Multiple result, see text
Lee et al. [26]	Attitude towards more wind turbines	Living in an area with wind turbines.	$\beta_{\text{Living with turbine}} > 0$ (significance, see text)
Andersen et al. [18]	Attitude towards wind turbine at the neighbour	Distance to the nearest wind turbines	$\beta_{\text{Distance}} < 0$ (significance, see text)
Braunholz [19]	Perception of the effect of the local wind farm	Distance to the wind farm	$\beta_{\text{Distance}} < 0$ (significance not reported)
	Attitude towards and 50% or 100% increase in the number of turbines	Distance to the wind farm	$\beta_{\text{Distance}}{}^{\text{NS}}$
		Number of turbines in the existing wind farm	$\beta_{\text{No. Turbines}}{}^{\text{NS}}$
Warren et al. [20]	Attitude towards two existing wind farms	Distance from residence to wind farm	$\beta_{\text{Distance}} < 0$ (significance, see text)
Johansson and Laike [21]	Intention to oppose existing wind turbines	Living at difference distances from existing wind turbines	$\beta_{\text{Distance}}{}^{\text{NS}}$
		View to local turbines	$\beta_{\text{View turbines}}{}^{\text{NS}}$
Ladenburg [16]	Attitude towards more on-land turbines	View to on-land turbines from permanent residence or summerhouse	$\beta_{\text{View on-land}}{}^{\text{NS}}$
			$\beta_{\text{View on-land and offshore}} < 0^{*}$
Ladenburg and Dahlgaard [10]	Attitude towards existing on-land turbines	View to on-land turbines from permanent residence or summerhouse	$\beta_{\text{View on-land}}{}^{\text{NS}}$
		View to offshore turbines from permanent residence or summerhouse	$\beta_{\text{View offshore}}{}^{\text{NS}}$
		Number of on-land turbines seen daily	$\beta_{\text{No. turbines neighbourhood}} < 0^{*}$
Ladenburg et al. [11]	Attitude towards more on-land turbines	View to on-land turbines from permanent residence or summerhouse	$\beta_{\text{View on-land}}{}^{\text{NS}}$
		View to offshore turbines from permanent residence or summerhouse	$\beta_{\text{View offshore}}{}^{\text{NS}}$
		Number of on-land turbines seen daily	$\beta_{\text{No. turbines neighbourhood}} < 0^{*}$
AMR Interactive [22]	Attitude towards a wind farm 1–2 km from the residence	Distance to the nearest turbine	$\beta_{\text{Distance}} > 0$
		View to on-land turbines from permanent residence	$\beta_{\text{View}} < 0$ (significance, see text)
Attitude/perception towards wind power			
Krohn and Damborg [27]	Attitude towards wind power	Living less than 500 m from existing turbines	$\beta_{\text{Distance}}{}^{\text{NS}}$
		Number of turbines visible from the residence of the respondents	$\beta_{\text{No. turbines visible}}{}^{\text{NS}}$
Ek [28]	Attitude towards wind energy	Living near turbine(s)	$\beta_{\text{Near turbines}}{}^{\text{NS}}$
Meyerhoff et al. [29]	Perception of the environmental quality	Number of encounters with wind turbines in the past 4 weeks	$\beta^{2}{}_{\text{Winter turbine encounters}}{}^{\text{NS}}$

[a] A smaller review, which is based on a previous version of this paper, is found in Ladenburg and Krause [30].
[b] The systematic differences in perception between respondents with experience with an offshore wind farm located 10 and 14 km from the coast, respectively, were tested across a large number of socio-demographic characteristics and found to be significant in 28 out of 34 variables at a 90% level of confidence.

Table 3
Acceptance of the number of wind turbines near the residence, based on Table 5 in [26].

Number of turbines	Phase I (%)[a]	Phase II (%)	χ^2-test[b]
8	47	61	25.5[1]***
16	27	43	34.2[1]***
30	21	27	6.0[1]*
50	–	17	
100	–	15	

[a] There were 423 and 1286 respondents in the Phase I and Phase II samples, respectively.
[b] The numbers in brackets are the degrees of freedom.
* Significance at a 95% level of confidence.
*** Significance at a 99.9% level of confidence.

Among different questions the respondents were asked, how many turbines they would accept near their residence. The results are presented in Table 3.

As the frequencies of acceptance suggest, the respondents in the Phase II sample are more positive towards wind power development in the area. Based on the number of respondents and the presented frequencies, we carry out a test for whether the level of wind turbine acceptance of the two samples origins from the same distribution of attitudes. As there is no information regarding the number of respondents accepting 50 or 100 turbines in the Phase I sample, the test is carried out with regard to the acceptance of 8, 16 and 30 turbines. The test statistics are reported in the rightmost column, and show that the attitudes are significant between the two samples.

In Andersen et al. [18] attitudes towards the location of a wind turbine at a neighbour are cross tabulated with regard to the distance to the nearest wind turbine. Table 1 in [11] presents the attitude frequencies and a χ^2 test proves that acceptability strongly declines with increasing distance to the nearest wind turbines.

Braunholz [19] tests the influence of the distance to specific wind farms and the number of turbines in the wind farms on the attitude towards both the perceived impact from the wind farms and the attitude towards an increase in the wind turbine capacity of the specific wind farms of 50% and 100%, respectively. Whilst there is no effect regarding the expansions of the wind farms, the author reports that people living within 10 km from the specific wind farms, perceive the effect from the local wind farm to be more positive, compared to respondents living between 10 and 20 km from the site. Unfortunately, it has not been possible to test if the effect is significant.

Warren et al. [20] conducted two surveys on attitudes towards existing and planned on-land turbines in two local regions in Scotland and Ireland. In the Irish study, the attitudes towards two specific wind farms in both Cork and Kerry are cross tabulated with the distance (0–5 km, 5–10 km and 10–20 km) from the residence of the individual respondent. The cross tabulation strongly suggests that the attitude towards the two wind farms in each area is more positive the closer the respondent lives to the wind farms. Based on the tabulated attitude frequencies, we carry out a χ^2 test of identical distributions of attitudes. Starting with the attitude towards the first wind farm that was established, it cannot be rejected that the respondents living between 0–5 km and 5–10 km from the wind farms (one in Kerry and one in Cork) are identical. However, when comparing the attitudes between respondents living 0–5 and 10–20 km from the wind farms, equality of attitudes can be rejected at a 10% level of confidence. Looking at the second group of turbines these numbers are even more evident. It should be noticed that the two “new” wind turbines established in Cork and Kerry are very different both compared to each other, but also compared to the first wind farms at the two sites. The first established wind farms in Cork and Kerry have eight and six turbines, respectively. The new turbines in Cork have nine turbines and are thus almost equal in size compared to the first wind farm. However, the second wind farm in Kerry has 23 turbines. These differences might be the drivers in the relations between attitude and the distance to the wind farms from the residence of the respondents.

In a study focusing on attitude and the intension to oppose local turbines Johansen and Laike [21] test if residential factors such as distance to the local turbines and view to the turbines influence attitude/opposition. None of the variables are found to be significant. The results thus point towards that having a view of an on-land wind turbine or having a turbine in the relative vicinity does not influence the attitude.

Ladenburg [16] also analyses the attitude towards future on-land turbines. The results suggest that in the case that the respondent can see both on-land and offshore wind turbines ($\beta_{View\ On\text{-}Land\ and\ Offshore}{}^{*}$) prior experience influences the attitude towards more on-land turbines. In that specific case, the effect is negative.

In Ladenburg and Dahlgaard [10], the influence of both having a view to both on-land and offshore wind turbines and the number of daily encounters with wind turbines are tested in relation to attitudes towards existing on-land wind turbines. The analysis suggests that having more than five turbines in the local area has a significant negative influence on the acceptance of the existing on-land turbines ($\beta_{>5\ turbines\ per\ day} < 0^{*}$). Having a view of on-land or offshore wind turbines does not seem to influence the attitude.

Ladenburg et al. [11] analyse the effect of the number of on-land wind turbines seen on a daily basis on the attitude towards more on-land wind turbines. The analysis suggests that having more than 20 turbines in the local area has a significant negative influence on the attitude towards more on-land turbines ($\beta_{>20\ turbines\ per\ day} < 0$). However, strikingly, the study finds evidence of that the relation between attitude towards more on-land wind turbines and the number of turbines seen on a daily basis only appears to present among the respondent who have an on-land wind turbine in the viewshed from the residence. Conditional on having an on-land wind turbine in the view, the negative attitude was increasing with the number of wind turbines seen daily ($\beta_{6\text{–}20\ turbines\ per\ day|On\text{-}land\ turbine\ in\ the\ viewshed} < 0$ and $\beta_{>20\ turbines\ per\ day|On\text{-}land\ turbine\ in\ the\ viewshed} < 0$). If the respondent did not have a wind turbine in the viewshed, the respondents who saw between 0 and 5 wind turbines per day were equally positive/negative as the respondents who saw 6–20 or more ($\beta_{6\text{–}20\ turbines\ per\ day|No\ on\text{-}land\ turbine\ in\ the\ viewshed}{}^{NS}$ and $\beta_{>20\ turbines\ per\ day|No\ on\text{-}land\ turbine\ in\ the\ viewshed}{}^{NS}$).

Finally, in a newly published report, attitudes towards wind power in six Renewable Energy Precincts in New South Wales, Australia were elicited and subsequently cross tabulated with different variables [22]. One of the cross tabulations presents the relation between *ex ante* attitude towards the establishment of a wind farm 1–2 km from the residence of the respondents and the distance to the nearest existing planned wind farm. Based on this, Ladenburg et al. [11] carry out a χ^2 test. Based on the test results, they conclude that the observed reduction in acceptance of the wind turbines at the neighbour is significantly influenced by the distance to the nearest existing wind turbines at a 95% level of confidence. The same report [22] also tests if the view to existing or planned wind turbines influences the attitude towards the above-mentioned project. In the table below, the frequencies and the results from the survey are put forward (see Table 4).

A χ^2 test strongly rejects that the attitudes are identical in the two samples, suggesting that people who presently cannot see a wind turbine from their residence are significantly more positive towards new turbines 1–2 km from the residence.

Table 4
Attitude towards new wind farm 1–2 km from the residence, based on Fig. 16 in AMR Interactive [22].

Number of turbines	Turbine in the view[a] (%)	No turbine in view (%)	χ^2-test[b]
Support	43	60	
Total oppose	54	33	13.0[2][**]
Do not know	3	7	

[a] There were 73 and 620 respondents in the “Turbine in the view” and “No turbine in view” samples, respectively.
[b] The numbers in brackets are the degrees of freedom.
[**] Significance at a 99% level of confidence.

2.3. Attitudes towards wind power and related studies

Krohn and Damborg [27] report from a Danish survey carried out in a local area with many turbines. They find that the distance to the nearest wind turbine does not seem to have an influence on the attitude. However, in the paper they argue that people who can see between 20 and 29 turbines from their home and people who are living within 500 m from the nearest wind turbine tend to be more positive towards wind power in general. Apparently, the trend is not significant.

In a Swedish study [28] attitudes towards wind power are analysed. In the study it is tested whether respondents who live near wind turbines have a different attitude towards wind power compared to respondents who do not live near turbines. The analysis could not establish such a connection ($\beta_{Near\ turbines}{}^{NS}$).

Finally, Meyerhoff et al. [29] test if the number of wind turbine encounters during the last 4 weeks influences the satisfaction of the regional environmental quality. Controlling for daily encounters, repeated encounter, encounter 2–3 times a week, only one encounter and no encounters at all, they find no significant differences in satisfaction.

2.4. Review summary

Summing up on the literature review, there seems to be relatively mixed results regarding the effect of prior experience with wind turbines and the attitude towards wind turbines. In the following we will focus on the effect from having wind turbines in the viewshed and the number of turbines/distance to the turbines.

We begin with the effect from having an on-land wind turbine/farm in the viewshed from the permanent or summer residence. Ladenburg [16] and Ladenburg et al. [11] find negative effects with regard to the attitude towards on-land turbines. It is though important to stress that found effects are conditional on also having an offshore wind turbine in the viewshed or having many turbines in the neighbourhood. Refs. [10,21,23,27] do not find an effect. Interestingly Ladenburg [9] find a cross-over effect of having a view to on-land turbines on the attitude towards offshore wind farm. Having on-land wind turbines in the viewshed increased the acceptance of offshore wind farms. Except from the above-mentioned effect in [16], view to offshore wind farms do not influence the attitude towards on-land or offshore wind farms [9–11,14].

The other dominant experience effect relates to the distance to wind turbines or the number of turbines in the local area. Perhaps best illustrated by the Lee et al. [26] study, the effects of distance/number of turbines are mixed. Refs. [18–20] find that distance seems to increase opposition. Refs. [21,27] find no effect from distance, whilst [22] find a positive effect. Regarding the number of turbines, [10,11] are the only two studies that find that the cumulative number of turbines influence attitude negatively. The other studies [9,19,27,29] do not.

3. Analytical framework

In the present paper, we want to specify an attitude model, which includes standard demographic variables, but also allows for experience with wind turbines to be a determinant of attitude. Previous research on wind power attitude formation and experience mainly defines differences in individual attitudes in a linear form. Individual i's attitude q_i thus is a function of the individual demographics, X_i, and a set of variables, θ_i, representing one or several dimensions of experience with wind turbines, i.e. $q_i + X_i\beta + \theta_i\varphi$. As illustrated in Table 2, θ_i typically includes information on whether the respondent lives near a wind turbine or has seen a turbine, i.e. a general visual encounter. In our analyses we also include this type of information such as having a view of on-land turbines or offshore wind farms from the residence and the number of turbines seen daily. Our main contribution to the existing literature is, however, that we include information on the travel time, TT_i, from the residence to the six (j) offshore wind farms in Denmark.

$$\theta_{ij} = \gamma No.\ \ turbines_i + \delta View\ \ on\text{-}land_i + \vartheta View\ \ offshore_i + \mu TT_{ij} \tag{1}$$

By including information related to the travel time, we will be able to infer if the distance to the existing offshore wind farms influences attitude, such as the studies in the review in relation to on-land turbines. However, we extend the analytical framework in another dimension. As suggested in Tables 1 and 5 the operating wind farms at EU level and in Denmark are very heterogeneous in relation to the number of turbines per wind farm, size of the turbines, the distance from the shore where the wind farms are located and the relation between the distance to the shore and the height of the turbines. More specifically in Denmark, turbine sizes between 450 kW and 2.3 kW had been used and the turbines were grouped in wind farms of different sizes (10–80 turbines) and installed at different distances from the coast (2.3–20 km) at the time the survey was carried out.

So dependent on which j offshore wind farm respondent i has the shortest travel time to, the attitude might vary. For example, respondents who live close to/have seen Middelgrunden offshore wind farm (20 turbines close to the shore) might have a different attitude compared to respondents who live close to/have seen Horns Rev Wind Farm (80 turbines located far from the shore). Consequently, the analytical framework will also include the attributes of each of the wind farms (number of turbines), the relation between distance to the shore and the height of the turbines (distance/height relation). This changes [1] into

$$\theta_{ij} = \frac{No.\ \ turbines_i + \delta View\ \ on\text{-}land_i + \vartheta View\ \ offshore_i + TT_{ij} + Number\ \ of\ \ turbines_{ij} + Distance}{height\ \ relation_{ij}} \tag{2}$$

Information on attitude stems from the respondents’ statements on a five-point scale ranging from *very positive*, *mainly positive*, *neutral*, *mainly negative* and *very negative* towards existing offshore wind farms. Initially, a model utilising the full range of the attitudinal data was tested by applying the Ordered Logit model [31]. However, subsequent analysis suggested that the 19 and 8 respondents having a *mainly negative attitude* or *very negative attitude* towards the existing offshore wind farms could be grouped. We categorise this group of respondents to have a *negative attitude*. Accordingly, in

Table 5
Attributes of operating Danish offshore wind farms.

Wind farm	Location	Number and capacity of turbines	Nub height[a] (m)	Distance from the shore	Distance/height relation[b]	Date of commission
Vindeby (VB)	North-West of Falster	11 × 0.45 MW	35 [53.5]	2.5 km	43	1991
Tunø Knob (TK)	East of Odder	10 × 0.5 MW	45 [64.5]	6 km	78–93	1995
Middelgrunden (MG)	East of Copenhagen	20 × 2 MW	64 [102]	2–3 km	15–25	2000
Samsoe (SA)	South of Samsoe	10 × 2.3 MW	61.2[103.5]	3–6 km	29–58	2002
Horns Rev (HR)	West of Esbjerg	80 × 2 MW	70 [110]	14–17 km	127–182	2002
Nysted (NY)	South of Nysted	72 × 2.3 MW	68.8 [110]	6–10 km	55–86	2003

[a] The number in brackets is the total height of the turbine.
[b] The ratio is the distance from the shore (in m) divided by the total height of the turbine.

our Ordered Logit model[3] the stated category value (q_i) is replaced with an individual continuous latent variable q_i^*.

$$q_i \left\{ \begin{array}{lll} 1 & \text{if} & q_i^* < \gamma_1 \\ 2 & \text{if} & \gamma_1 \le q_i^* < \gamma_2 \\ 3 & \text{if} & \gamma_2 \le q_i^* < \gamma_3 \\ 4 & \text{if} & \gamma_3 \le q_i^* < \gamma_4 \end{array} \right\} \tag{3}$$

With this setup six models are elicited. The first model, "Model I", is the base model, in which the attitude is regressed on the standard demographics of the respondents. Except for minor difference it is a replica of the model referred to as the "Main Model" in Ladenburg [9]. In the second model, the attitude and prior experience relation are analysed using information on the travel time (*TT*) from respondent *i*'s residence to the *nearest* offshore wind farm, TT_{WindI}. Before moving on to the actual estimated models, it is worth putting forward that the analytical framework does not control for experience with more than one wind farm. Naturally, this setup has been tested, and the model does not improve by adding variables that control for the travelling time to the second or third nearest wind farm.

With respect to the travel time, several models have been tested. The final model includes three variables that relate the travel time to the nearest offshore wind farm to the attitude. The first variable *TTWind I_30* controls for whether the respondent lives within 30 min drive from the nearest offshore wind farm. The second and third variables control for the travelling time to the nearest wind farm as linear and quadratic functions, *TTWind I* and *TTWind I*^{2}. We call this "Model II". In the third model, "Model III", we include information related to the attributes of the nearest wind farm, such as the number of turbines, *Wind I_N.Turbines* and the relation between the distance to the shore and the height of the turbines, *Wind I_DH*. In "Model IV", we exclude the attributes of the nearest wind farm, but include dummy variables controlling for which of the six wind farms that is the nearest. These variables are *TTWind I_NY*, *TTWind I_HR*, *TTWind I_MG* and *TTWind I_VB* and *TTWind I_TK* and control for whether the wind farm with the shortest travel time is Nysted (NY), Horns Rev (HR), Middelgrunden (MG), Vindeby (VB) or Tunø Knob (TK) using the wind farm at Samsø South as a benchmark. The fifth and sixth model, "Models V and VI", are similar to Models III and IV, except for that we include information on the perceived impacts offshore wind farms have on the coastal landscape, bird life and the life in the sea. We name these variables *Impact Landscape*, *Impact Birds* and *Impact Life Sea*. Before moving on to the analysis and results section, it should be mentioned that the nature of the data, i.e. an increase in the latent value for q_i^*, denotes an increasing opposition towards offshore wind farms. Accordingly, φ and $\beta > 0$ denotes that the variable influences the attitude negatively and vice versa.

[3] As we only have one observation per individual, we have limited the analysis to using a simple ordered logit model.

3.1. Limitations

Unfortunately, the survey did not include a question related to how frequently and which offshore wind farms the respondents actually had visited. We are therefore not able to test for actual physical experience with the offshore wind farms, but are limited to proxy experience by the travel time to the offshore wind farms. Our approach is though in line with previous studies such as [18–22].

It should also be put forward that the frame of the analysis of attitude is the existing offshore wind farms. Accordingly, we measure an *ex post* attitude towards existing wind turbines and not an *ex ante* attitude towards new turbines. Consequently, the survey is based on the answers from respondents, who were living at a given residence, when we elicited their attitudes. If the choice of residence has been motivated by the impact from offshore wind farms on for example frequency of beach visits, for an example thereof see [24,32,33], this could have a significant influence on the attitudes that we measure and the relation between attitude and distance. More specifically, people who really dislike offshore wind farms might have moved away or refrained from moving to areas with offshore wind farms. As the number of offshore wind farms is still low, we assume that the number of cases in which respondents deliberately has moved away from the offshore wind farms are few. In relation to on-land turbines, this is supported by the findings in Braunholz [19]. Accordingly, we perceive this to be a minor issue.

Finally, we only relate the effect of travel distance and the attributes of the wind farms in a framework that relates attitude to a physical experience with offshore wind farms. We acknowledge that physical encounters are just one source of prior experience. Prior experience or perhaps more correctly prior information can be obtained from various numbers of sources, such as indirect experience, such as relatives' or friends' experience with wind turbines or media coverage, see [17,19,22] for an example thereof. However, in the present analysis information related to these sources of prior information is unfortunately not available. The present analytical framework is therefore also limited to measure experience related to visual/physical encounters with actual turbines.

4. Modelling of prior experience as a function of transport time

Geographical proximity to offshore wind farms can be defined in several ways. The simplest concept is the distance as the crow flies, calculated as the planar distance in the Euclidean space. This may work well over shorter distances where proximity is given by direct visibility (typically up to 20 km), but not proximity within a regional or national scale, where a wind farm is not visible unless you see it as a more or less frequent visitor, or where other notions of nearness apply. In these cases other forms of proximity apply, given by the relative transport effort or accessibility in terms of road distance or travel time by car. In a country like Denmark, where



Fig. 1. Location of offshore wind farms in 2006.

accessibility is severely restricted by topographical features such as the sea, peninsulas and islands, Euclidean distance and travel time are highly dissimilar.

The study uses a geographical information system (GIS) and network analysis to link the proposed offshore wind farm sites to the geostatistical entities of the survey participants. Locations of wind farms were mapped as the approximate centroids of the areas sketched in Fig. 1.

As the study uses postal districts to geographically locate survey participants, the centroids of a postal district theme [34] were used. A road network database [35] with a simplified road network structure including road segment length and average car speed was used to link wind farm locations and postal district centroids. It was hereby assumed that the link from the wind farm to the road network happened through the road segment nearest to the coast, using a straight line distance.

The variables used to analyse proximity are road distance, which is the distance travelled via the road network, as well as travel time, which is the accumulated time spent on travelling along the road distance at speeds recorded for every road segment. Distances from all wind farms to all postal district centroids were calculated using the ArcGIS version 9.2 including Network Analyst.

Inaccuracies and uncertainties in the applied method appear in several places. First of all, the concept of road distance and travel time is only an approximation of proximity. Whilst better than Euclidean distance, it still excludes personal preferences, cognitive aspects of nearness, and the general image of the coastal areas and their accessibility. Further inaccuracies appear in using the postal district and wind farm centroids rather than the exact location of residence and the wind farm boundaries. The errors in distance and travel time are, however, assessed to be less than 4% and often as little as 1% for the majority of the population. As the road network database is an older version available to the researchers, some new roads and motorways are not included, resulting in overestimated distances and travel times. Finally, uncertainty prevails in the calculated travel times like function of distance and speed, which leaves out road congestion and stops at traffic lights, and neglects personal preferences in travel patterns.

5. The study

The analysis of attitude towards offshore wind farms and the influence of travel time and the attributes of the nearest offshore wind farms are based on the sample used in Ladenburg [9]. This is a randomised sample of respondents from a nationwide Internet panel consisting of approximately 17,000 people. In total, the effective sample was set to 1050 answers. To obtain this sample, invitations to answer the questionnaire were emailed to the 1860 panel members in July 2006. Of these 1088 filled in the questionnaire, whereof 1082 respondents stated an attitude towards the existing offshore wind farms and filled in all questions regarding the background characteristics of the respondents. The demographics characteristics of the effective sample are presented in Table 6.

The average respondent, hereafter AR, in the survey is approximately 45 years old (*Age*). AR has at least completed 9 years of elementary school (*School*) and has a non-vocational secondary education or a bachelor (*Education*), taking into account that 12% of the sample has no education except from primary and secondary school (*No sec. education*). AR belongs to a household with an annual

Table 6
Characteristics of the sample.

Characteristic	Mean	S.D.	Coding
Gender	0.53	0.50	= 1 if male, else = 0
Age	45.04	15.82	Continuous
School	3.36	0.83	= 1 if 7 or less years in primary school = 2 if 8–9 years in primary school = 3 if 10 years of primary school = 4 if high school
Education[a]	3.61	1.40	= 1 if vocational upper secondary school = 2 if vocational education = 3 if Non vocational secondary education. = 4 if Bachelor degree = 5 if Master's degree = 6 if other education
No sec. education	0.12	0.32	= 1 if no education, else = 0
Household income	2.59	1.35	= 1 if income = 0–199,999 = 2 if income = 200–399,999 = 3 if income = 400–599,999 = 4 if income = 600–799,999 = 5 if income >800,000
Number of turbines seen daily	1.91	1.02	= 1 if 0–5 turbines = 2 if 6–10 turbines = 3 if 11–20 turbines = 4 if >20 turbines
Number of turbines seen daily do not know	0.49	0.50	= 1 if do not know, else = 0
View on-land turbines	0.24	0.43	= 1 if view from residence or summer house, else = 0
View offshore turbines	0.05	0.22	= 1 if view from residence or summer house, else = 0
Walk beach	0.54	0.50	= 1 if yes, else = 0
Number of summer visits	2.18	1.15	= 1 if ≥1 visit per week = 2 if 1–3 visits per month = 3 if 1 every second month = 4 if 1 every half-year = 5 if less than 1 every half-year
Number of winter visits	3.21	1.33	= 1 if ≥1 visit per week = 2 if 1–3 visits per month = 3 if 1 every second month = 4 if 1 every half-year = 5 if less than 1 every half-year
Number of summer and winter visits do not know	0.01	0.07	= 1 if do not know, else = 0
Travel time to Nysted	161.94	68.15	Continuous (min)
Travel time to Horns Rev	159.16	47.86	Continuous (min)
Travel time to Middelgrunden	104.22	81.20	Continuous (min)
Travel time to Vindeby	155.20	55.41	Continuous (min)
Travel time to Samsoe	175.50	32.77	Continuous (min)
Travel time to Tunø Knob	188.92	52.90	Continuous (min)

[a] Initially, a category representing other types of education was in the questionnaire. The subsequent analysis of attitude towards offshore wind farms and education revealed that the respondents stating an "other type of education" on average had an attitude like the respondents with a vocational education. In the analysis of attitude, the respondents with an "other type of education" were therefore recoded as being respondents with a vocational education.

income (*Household income*) between 399,999 and 600,000 DKK.[4] With regard to the experience with wind turbines, AR sees between 0 and 10 turbines daily, conditional on knowing the number of turbines seen (*Number of turbines seen daily*). AR's probability of seeing an on-land turbine from the permanent residence or summer house (*View on-land turbines*) is 24% compared to a probability of 5% of seeing offshore wind turbines (*View offshore turbines*). AR has a 50% probability to visit the beach, when taking a recreational walk (*Walk beach*). More specifically, AR visits the beach between one to several times every second month during the summer (*Number of summer visits*) and at least once during the winter (*Number of winter visits*). The average driving time to each of the six offshore wind farms is between 104 and 189 min, though with relatively large levels of standard deviations.

6. Results

Generally, attitudes towards the offshore wind farms in commission are very positive in the sample. Of a total sample of 1082 respondents, only 27 are found to have a negative attitude. Furthermore, more than half of the respondents have stated that they are very positive towards the wind farms, see Table 7.

The stated attitudes indicate a strong positive perception towards offshore wind farms. Nevertheless, just "eye-balling" the attitudes might miss potential relations between attitude and prior experience. Accordingly, the respondents stating a negative attitude might represent a unique prior experience. Or stated differently, the propensity to have a negative attitude or "just" being mainly positive might be correlated with the experience with offshore wind farms. These relations are analysed in the Ordered Logit model, which is presented in Table 8.

Table 7
Stated attitudes towards existing offshore wind farms.

Attitude	Ordered Logit model	Frequency of attitude
Very positive	$q = 1$	652
Mainly positive	$q = 2$	335
Neutral	$q = 3$	68
Negative	$q = 4$	27

[4] At the time of the survey 745.65 DKK were approximately100 Euro [36].

Table 8
Ordered Logit model analysis of attitude.

	(1) Model I	(2) Model II	(3) Model III	(4) Model IV	(5) Model V	(6) Model VI
Age	0.00834+	0.00753+	0.00809+	0.00810+	0.00881+	0.00897+
	[1.83]	[1.65]	[1.76]	[1.76]	[1.71]	[1.74]
Gender	−0.325*	−0.334**	−0.351**	−0.353**	−0.392**	−0.396**
	[−2.52]	[−2.58]	[−2.70]	[−2.70]	[−2.65]	[−2.68]
Household income	0.0972*	0.0962*	0.0969*	0.0984*	0.144**	0.152**
	[2.03]	[2.00]	[2.01]	[2.02]	[2.71]	[2.82]
School	−0.0301	−0.0209	−0.0357	−0.0345	−0.0493	−0.0420
	[−0.20]	[−0.14]	[−0.24]	[−0.23]	[−0.30]	[−0.25]
Vocational upper secondary school	0.0714	0.0562	0.0566	0.0566	0.125	0.133
	[0.22]	[0.18]	[0.18]	[0.18]	[0.35]	[0.37]
Vocational education	0.329	0.303	0.285	0.276	0.454+	0.444
	[1.35]	[1.24]	[1.17]	[1.13]	[1.67]	[1.63]
Longer secondary education	−0.185	−0.209	−0.226	−0.227	−0.0754	−0.0704
	[−0.76]	[−0.86]	[−0.92]	[−0.93]	[−0.28]	[−0.26]
Bachelor	0.151	0.157	0.167	0.162	−0.00474	−0.0196
	[0.80]	[0.83]	[0.87]	[0.85]	[−0.02]	[−0.09]
Master	0.451*	0.461*	0.473*	0.466*	0.274	0.264
	[2.07]	[2.09]	[2.15]	[2.11]	[1.14]	[1.10]
Walk beach	0.388**	0.364*	0.370*	0.374*	0.198	0.207
	[2.66]	[2.48]	[2.52]	[2.54]	[1.23]	[1.28]
Visit summer	−0.0109	−0.00433	−0.00124	−0.00061	0.0566	0.0570
	[−0.15]	[−0.06]	[−0.02]	[−0.01]	[0.70]	[0.70]
Visit winter	−0.0670	−0.0724	−0.0735	−0.0744	−0.0404	−0.0394
	[−0.95]	[−1.02]	[−1.03]	[−1.04]	[−0.52]	[−0.50]
No. turbines >20	0.207	0.151	0.216	0.230	0.238	0.265
	[0.65]	[0.47]	[0.66]	[0.70]	[0.67]	[0.75]
No. turbines 11–20	0.169	0.128	0.121	0.131	0.324	0.332
	[0.62]	[0.47]	[0.44]	[0.48]	[1.07]	[1.09]
No. turbines 6–10	0.222	0.193	0.222	0.227	0.175	0.190
	[1.03]	[0.89]	[1.02]	[1.04]	[0.73]	[0.80]
No. turbines do not know	0.347*	0.320*	0.299+	0.292+	0.209	0.197
	[2.19]	[1.98]	[1.85]	[1.80]	[1.17]	[1.10]
View offshore	−0.217	−0.166	−0.172	−0.171	0.0861	0.0762
	[−0.73]	[−0.55]	[−0.57]	[−0.57]	[0.26]	[0.23]
View on-land	0.322*	0.374*	0.394*	0.395*	0.322+	0.325+
	[2.02]	[2.31]	[2.42]	[2.42]	[1.80]	[1.81]
TTWind I_30		0.716**	0.760**	0.725**	0.826**	0.776*
		[2.67]	[2.76]	[2.60]	[2.73]	[2.52]
TTWind I		0.0171*	0.0172*	0.0162*	0.0154*	0.0123
		[2.45]	[2.42]	[2.09]	[1.98]	[1.44]
TTWind I^2		−0.000064*	−0.000066*	−0.000063+	−0.000062+	−0.000049
		[−2.01]	[−2.07]	[−1.81]	[−1.77]	[−1.30]
TTWind I_No. turbines			−0.00669+		−0.00807+	
			[−1.68]		[−1.83]	
TTWind I_DH			0.00140		0.00343	
			[0.49]		[1.09]	
TTWind I_NY				−0.629		−0.483
				[−1.00]		[−0.72]
TTWind I_HR				−0.418		−0.502
				[−1.43]		[−1.57]
TTWind I_MG				−0.187		−0.453
				[−0.65]		[−1.44]
TTWind I_VB				−0.184		−0.425
				[−0.49]		[−1.03]
TTWind I_TK				−0.0586		−0.139
				[−0.25]		[−0.54]
Impact landscape					1.183***	1.186***
					[12.59]	[12.58]
Impact birds					0.474***	0.482***
					[3.46]	[3.51]
Impact life sea					0.264+	0.266+
					[1.79]	[1.79]
Impact birds do not know					−1.445**	−1.453**
					[−3.23]	[−3.24]
Impact life sea do not know					−0.135	−0.158
					[−0.26]	[−0.30]
$\gamma 1$	2.055***	2.946***	2.915***	2.791***	8.701***	8.344***
	[4.16]	[4.92]	[4.83]	[4.17]	[10.38]	[9.43]
$\gamma 2$	4.028***	4.932***	4.903***	4.780***	11.23***	10.87***
	[7.94]	[8.05]	[7.94]	[7.01]	[12.83]	[11.84]
$\gamma 3$	5.713***	6.618***	6.589***	6.467***	13.22***	12.87***
	[10.42]	[10.23]	[10.11]	[9.08]	[14.33]	[13.37]
N	1082	1082	1082	1082	1082	1082

Table 8 (*Continued*)

	(1) Model I	(2) Model II	(3) Model III	(4) Model IV	(5) Model V	(6) Model VI
AIC	1996.0	1993.6	1994.3	2000.1	1669.5	1674.5
ll(0)	−996.1	−996.1	−996.1	−996.1	−996.1	−996.1
LL (at model convergence)	−977.0	−972.8	−971.2	−971.1	−803.7	−803.2
χ^2	38.31	46.68	50.00	50.18	384.8	385.8

t-Statistics in brackets.
* $p<0.05$.
** $p<0.01$.
*** $p<0.001$.
+ $p<0.10$.

The main focus of the regression results relates to the estimated parameters of the relation between attitude towards existing offshore wind farms and the individual distances to the six offshore wind farms across the six models. The results regarding the standard demographic variables will be briefly commented in the following. For a more detailed description and for more models, see Ladenburg [9].

Starting with the Main Model, the results suggest that gender, age, income, educational level, frequency of visits to the beach and the experience with on-land turbines seem to influence the attitude towards existing offshore wind farms at a 90% level of significance. More specifically, male and older respondents and respondents from higher income households seem to have a less positive attitude (β_{Gender}, β_{Age} and $\beta_{Household\ income}>0$). The level of education has a unidirectional influence on the attitude. The variable “School”, controls for the respondents who only have finished 7 years of elementary school, relative to the respondents who have completed 9 or 10 years of elementary school or high school. $\beta_{school}>0$, accordingly, these respondents are more negative towards offshore wind farms. Contingent of having a non-vocational secondary education[5] ($\beta_{Longer\ secondary\ education}$), respondents who have graduated from university with a master's degree seem to be more negatively inclined compared to respondents with 1–2 years of non-vocational secondary education ($\beta_{Master}>0$). Respondents reporting that they generally use the beach when they go for a walk have a higher propensity to have a positive attitude compared to respondents, who do not walk frequently on the beach ($\beta_{Walk\ beach}<0$). The results point towards that respondents who specifically visit the beach at least once a week during both winter and summer seasons appear to be significantly more negatively inclined towards existing offshore wind farms compared to the respondents only visiting the beach frequently during the summer or at a generally low level ($\beta_{Visit\ winter}>0$).[6] These results suggest that respondents using the coastal area intensively and independent of the season perceive offshore wind farms differently. Assuming that a visit to the beach represents a positive probability of an experience with offshore wind farms, this suggests that experience with offshore wind farms can have both a negative ($\beta_{Visit\ winter}>0$) and a positive effect on attitude ($\beta_{Walk\ beach}<0$), depending on the nature and distribution of the visits. Interpreted with reference to the model specification, see Eq. (1), this points towards that $\theta_i\varphi$, i.e. usage of the coastal zone, has a significant influence on the attitude formation towards offshore wind farms.

Testing for some of the simple attitudes and prior experience (View on-land, View offshore) associations reveal that the view of offshore wind farms from the residence or summer house seems not to influence the attitude ($\beta_{\text{View offshore}}{}^{NS}$). However, respondents who can see on-land turbines from their permanent or/and summer residence appear to be more positively inclined towards the offshore wind farms, $\beta_{View\ on\text{-}land}<0^{\dagger}$. In this relation it is worth putting forward that apparently it is the mere presence of on-land turbines and not the number of turbines that are encountered daily, which drives the attitude ($\beta_{No.T\ urbines\ daily}$ are all insignificant at a 90% level).[7]

6.1. Model II

In Model II, prior experience is as previously mentioned represented by three variables controlling for the travel time to the nearest offshore wind farm, *TTWind I_30*, *TTWind I* and *TTWind I*^{2}.

The results point towards that the travel time to the nearest offshore wind farm seems to influence the attitude significantly. However, the results also suggest that the effects are not linear. More specifically, $\beta_{TTWind\ I}$ and $\beta_{TTWind\ I^2}$ are significant and with a positive and negative sign, respectively. This indicates that the further away the respondent lives from any of the six offshore wind farms the more negatively inclined the respondent is towards existing offshore wind farms, though at a decreasing rate. However, the attitude is also dependent on whether or not the respondent lives within 30 min travel time from the nearest offshore wind farm. These respondents are thus significantly more negatively inclined towards offshore wind farms, $\beta_{TTWindI_30}>0$. This suggests some kind of proximity effect from the offshore wind farms.

6.2. Model III

In model III, the attributes of the nearest offshore wind farm have been included in order to explain variation in attitudes. The results suggest that the number of turbines influence the attitude significantly and that offshore wind farms with many turbines have a positive influence on the attitude $\beta_{Wind\ I_N.Turbines}<0$. The relation between the height of the turbines and the distance to the shore does not seem to influence the attitude significantly $\beta_{Wind\ I_DH}{}^{NS}$. Given that the distance/height relation is an expression of the visual

[5] The variable is a dummy variable controlling for whether the respondent has a longer non-vocational education.

[6] It is important to stress that the nature of the stated visit frequency during both summer and winter has an important implication for the interpretation of the estimated parameters for Visit summer and Visit winter. More specifically, respondents who visit the beach at least once a week during the winter also visit the beach at least once a week during the summer, but not the other way around. This means that Visit winter becomes a dummy variable for the respondents visiting the beach at least once a week during both seasons, whilst Visit summer represents respondents visiting the beach at least once during the summer season.

[7] The potential influence from the number of turbines has been analysed using linear and log linear. None of these gave a significant parameter estimate. However, as discussed in Ladenburg [14] using the number of turbines might be an insufficient measure of experience with turbines, if the visual impacts from the individual turbines are very heterogeneous, see [37]. It has also been tested, if the cumulative effects are conditional on having a wind turbine in the viewshed form the residence. Tests could not identify such significant effects.

impacts from the individual wind farms (δ*visual impacts*/δ*distance height relation* < 0), the visual impacts from the nearest offshore wind farm do not seem to have an effect on the level of acceptance of the existing offshore wind farms.

6.3. Model IV

In model IV we test if it is the wind farms themselves and not the attributes that influence the attitude. This is done by controlling for which of the six wind farms are the nearest. The included variables are *TTWind I_NY*, *TTWind I_HR*, *TTWind I_MG* and *TTWind I_SS* and *TTWind I_TK* and control for whether the wind farm with the shortest travel time is Nysted (NY), Horns Rev (HR), Middelgrunden (MG), Samsø South (SS) or Tunø Knob (TK) using the wind farm at Vindeby (VB) as a benchmark. None of the variables are significant at a 90% level of confidence. It seems though that having the shortest travel time to Horns Rev and Nysted, the largest wind farms at the time the survey was carried out, has a relatively large influence on the attitude. These results support the results from the previous model, in which larger numbers of wind turbines in the wind farm influence the attitude positively.

6.4. Models V and VI

In models V and VI we include information on the perceived impact from offshore wind farms on the coastal landscape (Visual impacts) and the coastal landscape, bird life and life in the sea. These variables strongly suggest that the perceived impacts in the three categories are significant predictors of attitude. The larger impacts the respondents perceive offshore wind farms have on the landscape, bird life and life in the sea, the more do they oppose the existing offshore wind farms. $\beta_{Impact\ landscape}$, $\beta_{Impact\ birds}$ and $\beta_{Impact\ life\ sea}$ all >0.

7. Discussion

The discussion of the analysis of how travel time to the nearest offshore wind farm and the wind farm attributes influence the attitudes towards offshore wind farms will focus on a comparison with previous studies and how the results can be used in the planning and siting of offshore wind farms, i.e. policy implications, in relation to the following main results.

7.1. Comparison with previous studies

The relations between attitude and distance to wind turbines are mixed in the literature.

Andersen et al. [18], Braunholz [19] and Warren et al. [20] find that distance to existing wind turbines reduces acceptability of wind turbines. Johansen and Laike [21] and Krohn and Damborg [27] find no effects, whilst Jones and Eiser [8] and AMR Interactive [22] find acceptance to increase with distance. The results from the studies are though difficult to compare, as the setups of the surveys are quite distinct. Ref. [8] applies distance in relation to proposed wind turbine development, compared to the other studies, which use the distance to existing on-land wind turbines. However, the setup of the other studies also differs. Braunholz [19], Warren et al. [20] and Johansen and Laike [21] analyse the attitude towards existing wind turbines. Andersen et al. [18] and AMR Interactive [22] focus on proposed wind turbines. Finally Krohn and Damborg [27] analyse distances in relation to a general attitude towards wind power. In that sense, our study is similar in the setup of [19–21]. Independent of which of the studies we compare with our results are unique in the sense that it is the first study that estimates and finds an effect of travel distance on the attitude towards offshore wind farms. Compared to [18–20] we also find a vicinity effect, which points towards that people living in relative vicinity to the offshore wind farms are more negative, taking into account a general increase in opposition with increasing distance.

7.2. Planning perspective

From a planning perspective, the results of the analysis suggest that people living at a relatively close distance to wind farms might evolve more negative attitudes towards offshore wind power. Interestingly, this points towards that offshore wind farms preferably should be located along coast lines with relatively low population densities, all things else being equal. Accordingly, the estimated parameters suggest that offshore wind farms might not be the panacea for wind power opposition, which is also put forward in Haggett [15]. Naturally, this is one of the first of hopefully future studies shedding light on the relation between experience with offshore wind farms and acceptance. However, the negative relation between travel time to the nearest offshore wind farm and the attitude towards offshore wind farms could on the other hand also point towards that experience with wind turbines, all things else being equal, could have a positive influence on the attitude towards wind turbines. If the more negative attitude as a function of travel time is an expression of lack of experience, we would expect attitude to improve as more people have the opportunity to visit/see offshore wind farms. These results are quite apparent in Lee et al. [26] in which living in an area with wind turbines as opposed to no turbines seems to increase the number of wind turbines people would accept in relative vicinity of the home of the respondents.

In this sense, as people gain experience with wind turbines either via the existing or new turbines, attitudes among those people who live far from the present offshore wind turbines might become more positive. However, in the same relation is also important to keep in mind that the number of offshore wind farms in Denmark and the EU still is low. Accordingly, the establishment of more offshore wind farms could have the opposite effect, potentially increasing opposition. Some coast lines might be perceived to be less suitable for offshore development. The location of offshore wind farms in such areas could have opposite effects and induce a strong negative attitude towards offshore wind farms, see [38,39] for a further discussion. However, such an analysis would require both data on actual experience with offshore wind farms and data in relation to the location of offshore wind farms. Further research is consequently needed.

If we look at the second main findings, we find that the number of wind turbines in the nearest offshore wind farm influence the attitude positively, whilst the visual impacts represented by the distance/height relation do not. To some extent this points towards that it is not the wind farm as such, but also the attributes of the wind farm that have an influence on the attitude towards offshore wind farms, which is in line with the stated preference literature focusing on the attributes of wind farms on-land [29,40] and offshore installations [32,33,41,42]. In a policy context these results indicate that the type of experience with offshore wind farms also matters and that apparently people seem to prefer them to be located in larger wind farms compared to smaller ones.

8. Conclusion

The literature holds numerous examples of how experience with wind turbines influences the acceptability of wind power. This is pointed out in our review, which also stresses that most of the studies are orientated towards on-land turbines. Less than a handfull of studies has explored the effect of offshore experience on the attitude towards offshore wind farms. In the present paper we give our

best shot at the apparent lack of evidence in the literature and estimate the effect from travel time to the nearest offshore wind farm and the attributes of the wind farm on attitude. The results suggest that higher levels of travel time influence the attitude negatively. However, the results also denote that people, living within 30 min from the existing offshore wind farms, are more negative – which suggests some kind of proximity effect. Regarding the attributes of the wind farm, people having larger wind farms as the nearest offshore wind farm are significantly more positive towards offshore wind farms.

Acknowledgements

The authors wish to thank Kirsten Rasmussen and Lene Holm Petersen both from AKF, Danish Institute of Governmental Research, Maria Skotte, Senior Business Developer DONG Energy and Sanja Lutzeyer, North Carolina State University for valuable comments. Any errors remaining are of course the sole responsibility of the authors.

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